

REMARKS

The Final Office Action mailed October 23, 2001, has been received and reviewed. Claims 1 through 47 are currently pending in the application. Claims 1 through 47 stand rejected. Applicant respectfully requests reconsideration of claims 1 through 47 based upon the remarks herein.

35 U.S.C. § 112 Claim Rejections

Claims 1 through 47 stand rejected under 35 U.S.C. § 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor, at the time the application was filed, had possession of the claimed invention. Applicant respectfully traverses this rejection, as hereinafter set forth.

The Examiner has the burden to demonstrate that there is a reasonable basis upon which to question enablement. *See, MPEP* § 2164.04 (*citing In re Wright*, 999 F.2d 1557, 1562 (Fed Cir. 1993)). At a minimum, the Examiner must give reasons for the uncertainty of the enablement. *See, Id. (citing In re Bowen*, 492 F.2d 859 (CCPA 1974)). In the instant case, the reasoning for the enablement rejection includes the allegation that the limitation “tungsten silicide” is a broad limitation that covers all forms of tungsten silicide. The Official Action also indicates that one having ordinary skill in the art would necessarily have to perform “tremendous undue experimentations” to determine how to form tungsten silicides using the processes claimed by the present invention. For these reasons, the present claims are rejected under 35 U.S.C. § 112, first paragraph.

To overcome an enablement rejection, the Applicant must demonstrate that the disclosure would have enabled the claims of the invention for one skilled in the art at the time the application was filed. *See, MPEP* § 2164.05. Applicant has demonstrated such in the numerous responses to the previous Office Actions, which arguments are incorporated herein by reference. Furthermore, Applicant hereby asserts that the claims of the present invention are enabled by the

disclosure of the present application and that one having skill in the art of tungsten silicide deposition techniques at the time the present application was filed would not have to perform undue experimentation to carry out the various embodiments of the present invention as recited by the claims.

“As long as the specification discloses at least one method for making and using the claimed invention that bears a reasonable correlation to the entire scope of the claim, then the enablement requirement of 35 U.S.C. § 112 is satisfied.” *See, MPEP* § 2164.01(b) (*citing In re Fisher*, 427 F.2d 833, 839 (CCPA 1970)). The Specification of the present invention accomplishes this. The scope of each of the independent claims is directed to a process for depositing a tungsten silicide film on a substrate, wherein the process includes the deposition of a nucleation layer of tungsten silicide followed by the deposition of a film of tungsten silicide over the nucleation layer of tungsten silicide by switching to dichlorosilane as the silicon source gas. The Specification discloses at least one method for making and using the claimed invention in accordance with the scope of the claims. Specifically, the Specification recites:

By way of example and not limitation, at a temperature of about 450 °C. and with a silane flow rate of about 400 sccm, this nucleation layer is deposited in about 1-25 seconds. This requires a flow of reactant gas (WF_6) of about 4 sccm and a flow of inert gases (Ar, N_2 , He) of about 2800 sccm. Following deposition of the nucleation layer the silicon source gas may be switched abruptly or gradually to dichlorosilane and the tungsten silicide film can be deposited to the desired thickness using the dichlorosilane as the source gas. *See, Specification* at col. 3, line 62 to col. 4, line 3.

The presence of this example in the Specification, which discloses a specific method for making and using the claimed invention, is sufficient to overcome the outstanding rejection under 35 U.S.C. § 112, first paragraph. *See, MPEP* § 2164.01(b) (*citing In re Fisher*, 427 F.2d 833, 839 (CCPA 1970)).

Furthermore, at the time the present application was filed, methods for depositing tungsten silicide films were well known. It was known that tungsten silicide films could be deposited on substrates in a chemical vapor deposition (CVD) process using a silicon source gas, such as silane, and a reactant gas, such as tungsten hexafluoride. *See, Specification* at col. 1,

lines 33-49. Processes for depositing tungsten silicide films using tungsten hexafluoride and dichlorosilane gases with the aid of plasma reactions were also known. *See, Specification* at col. 1, lines 50-66. Even the specific deposition conditions and flow rates for producing tungsten silicides films represented by the formula WSi_x were recognized and were well known as evidenced by the citations in the Official Action to Brors (U.S. Pat. 4,851,292) and Ohba (U.S. Pat. 4,902,645). What was not known, however, was that a tungsten silicide film could be deposited using the processes described, and claimed, with respect to the present invention. Using the processes claimed as the present invention, known tungsten silicide films could be produced using known flow rates for the silicon source gas and reactant gas. No undue experimentation is necessary to use the processes of the present invention and the claims are enabled.

A number of factors may be considered in determining whether or not a disclosure fails to satisfy the enablement requirement of 35 U.S.C. § 112, first paragraph, because undue experimentation would be required to carry out the claimed invention. These factors include: (1) the breadth of the claims; (2) the nature of the invention; (3) the state of the prior art; (4) the level of one of ordinary skill; (5) the level of predictability in the art; (6) the amount of direction provided by the inventor; (7) the existence of working examples; and (8) the quantity of experimentation needed to make or use the invention based on the content of the disclosure. *See, MPEP* § 2164.01(a) (*citing In re Wands*, 858 F.2d 731, 737 (Fed. Cir. 1988)). Analyzing these factors, one having ordinary skill in the art would not have to carry out undue experimentation to use or understand the claimed processes of the present invention.

The breadth of the claims, and nature of the invention, cover a process for depositing a tungsten silicide film. Processes for depositing tungsten silicide films were well known at the time the present application was filed, especially CVD processes. It was also known that such processes could be used to deposit various forms of tungsten silicide by altering the deposition conditions. One having ordinary skill in the art would have no problem determining the flow

rates, or other deposition parameters, that would be required to form a particular tungsten silicide film using the known processes.

Although tungsten silicide deposition techniques using CVD processes were known, the processes described and claimed by the present invention were not known. The Specification, however, details the new processes that may be employed to deposit a tungsten silicide film using a CVD reaction chamber. One having ordinary skill in the art at the time the patent application was filed would be able to easily follow the techniques described by the Specification to carry out the invention claimed. In addition, the Specification discloses working examples of various processes and deposition conditions that may be employed to carry out the present invention. Based upon the disclosure contained within the Specification, one having ordinary skill in the art would not need to carry out any experimentation to deposit a tungsten silicide on a substrate using the processes recited by the claims of the present invention.

The recitation of the term “tungsten silicide” in the claims of the present invention does not render the claims unpatentable because the claims recite a process for depositing a tungsten silicide film. Furthermore, at least one working example of the processes claimed is described in the Specification, thereby overcoming any enablement rejection under 35 U.S.C. § 112, first paragraph. Additionally, undue experimentation is not required to carry out the claimed embodiments of the present invention because one having skill in the art at the time the present application would have been able to easily follow and use the claimed processes to deposit a tungsten silicide film on a substrate. “A specification disclosure which contains a teaching of the manner and process of making and using an invention in terms which correspond in scope to those used in describing and defining the subject matter sought to be patented must be taken as being in compliance with the enablement requirements of 35 U.S.C. § 112.” *See, MPEP* § 2164.04. Thus, claims 1 through 47 are enabled and should be allowed over the current 35 U.S.C. § 112, first paragraph rejection.

35 U.S.C. § 103(a) Obviousness Rejections

Obviousness Rejection Based on Japanese Patent No. 2-39528 to Kanwanishi et al. in view of U.S. Patent No. 4,632,057 to Price et al.

Claims 1, 2, 4, 5, 8, 9, 12 through 19, and 21 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kawanishi et al. (Japanese Patent No. 2-39528) in view of Price et al. (U.S. Patent No. 4,632,057). Applicant respectfully traverses this rejection, as hereinafter set forth.

Kawanishi teaches a two-step tungsten silicide deposition process. A first tungsten silicide film is formed on a substrate in the presence of silane (SiH_4) and tungsten hexafluoride (WF_6) at a temperature of 360°C . The substrate is then transferred to a second reaction chamber wherein a second tungsten silicide deposition is carried out in the presence of dichlorosilane (SiH_2Cl_2) and tungsten hexafluoride (WF_6) at a temperature of 680°C . *See, Kawanishi* at 6. Kawanishi makes it clear that the first deposition is a low temperature deposition and the second deposition is a high temperature deposition. Kawanishi also notes that a low temperature deposition followed by a high temperature deposition is preferred because low temperature depositions alone are disadvantageous. *See, Kawanishi* at 4.

Price et al. teach a one-step tungsten silicide deposition process initiated by a plasma discharge within a deposition chamber. Price et al. clearly teach that “the plasma discharge appears necessary to initiate/nucleate deposition.” *See, Price et al.* at col. 5, lines 60-63 (emphasis added). The single-step deposition process occurs in the presence of dichlorosilane (SiH_2Cl_2) and tungsten hexafluoride (WF_6) at a temperature of 450°C after deposition initiation is triggered by plasma discharge. *See, Price et al.* at col. 9, lines 1-12. . Hence, Price et al. imply that a low temperature deposition using dichlorosilane and tungsten hexafluoride is not possible without a plasma discharge.

M.P.E.P. 706.02(j) sets forth the standard for a Section 103(a) rejection:

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, **there must be some suggestion or motivation, either in the**

references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or combine reference teachings. Second, there must be a reasonable expectation of success. Finally, **the prior art reference (or references when combined) must teach or suggest all the claim limitations.** The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). (Emphasis added).

The 35 U.S.C. § 103(a) obviousness rejections of claims 1, 2, 4, 5, 8, 9, 12 through 19, and 21 are improper because Kawanishi and Price et al., either individually or collectively, fail to support a *prima facie* case of obviousness. Neither of the references teach or suggest all of the claims limitations of the present invention and there is no suggestion or motivation, either in the references themselves or in the knowledge generally available to one of skill in the art, to combine the reference teachings. Applicant's arguments from previous responses to Official Actions are hereby incorporated by reference as the present rejection is a repetition of the previous rejections.

Independent claims 1 and 8 each recite the following limitation:

depositing a film of tungsten silicide on the nucleation layer using a (CVD) process by switching to dichlorosilane (SiH_2Cl_2) as a silicon source gas such that the dichlorosilane gas reacts with the reactant gas to form the tungsten silicide film at a temperature of less than about 500 °C.

The Official Action recognizes the fact that Kawanishi fails to teach or suggest the deposition of a tungsten silicide film using dichlorosilane as a silicon source gas at a temperature below 500 °C as recited in claims 1 and 8. *See, Official Action* at p. 4. To overcome Kawanishi's failure to teach or suggest all of the claim limitations and establish a *prima facie* case of obviousness, the Official Action relies upon the teachings of Price et al. However, no motivation exists either in the references themselves, or in the art, to combine the teachings of Price et al. with Kawanishi to make obvious the present invention. Furthermore, there is no indication that the combination of Price et al. with Kawanishi could result in a viable deposition process without a plasma discharge.

Price et al. specifically teaches a single stage deposition process whereby tungsten disilicide is deposited on a substrate only after a plasma discharge within a CVD reaction chamber initiates the deposition process. Specifically, Price et al. “found that the plasma discharge appears necessary to initiate/nucleate deposition” of tungsten disilicide when using dichlorsilane as a silicon source gas. *See, Price et al.* at col. 5, lines 60-63; col. 9, lines 10-12 (emphasis added). Price et al. does not indicate that tungsten disilicide may be deposited, using dichlorosilane as a silicon source gas, on another layer of tungsten disilicide without the presence of a plasma discharge. The Official Action recognizes the fact that the deposition of tungsten disilicide, as taught by Price et al., requires a plasma discharge to initiate a reaction because tungsten disilicide can be deposited by CVD from dichlorosilane and tungsten hexafluoride “once a nucleation layer of tungsten disilicide was formed by initiating a plasma discharge.” *See, Official Action* at pages 4-5 (emphasis added). There is no indication in the disclosure of Price et al. that deposition of tungsten disilicide using dichlorosilane as a silicon source gas at a temperature of less than 500 °C may occur on a nucleated layer of tungsten disilicide without first initiating a plasma discharge.

Contrary to the assertions in the Official Action, no suggestion or motivation exists in the references, or in the art, that would lead one having ordinary skill in the art to modify or combine the reference teachings to make obvious the claims of the present invention.

One of skill in the art would not find it “obvious to deposit the WSi_2 film of Kawanishi at the temperature range suggested by Price” to improve thermal budget because neither reference indicates that a tungsten disilicide film can be deposited using dichlorosilane as a silicon source gas without a deposition temperature higher than 500 °C or in the presence of a plasma discharge. Kawanishi discloses that a high deposition temperature of at least 680 °C is required to deposit tungsten disilicide using dichlorosilane as a silicon source gas and Price et al. discloses that tungsten disilicide may be deposited from dichlorosilane in the presence of tungsten hexafluoride only after a plasma discharge. A combination of these references results in either a plasma

initiated deposition of tungsten disilicide or a deposition at a temperature greater than the 500 °C limitation recited in claims 1 and 8. Thus, a *prima facie* case of obviousness is not met.

Furthermore, Kawanishi teaches away from any combination with Price et al. or any other low-temperature deposition process “low-temperature treatment [has] a poor adhesion with the substrate and a poor step coverage.” *See, Kawanishi* at p. 4. Understanding Kawanishi, one having skill in the art would not think to combine Kawanishi with a second-step low-temperature deposition because of the resultant undesirable characteristics disclosed by Kawanishi.

Furthermore, one having ordinary skill in the art would not have combined Kawanishi and Price et al. based on the assertion that “the application of an old process to make the same would have been within the level of an artisan.” *See, Official Action* at 6. The reasoning supporting this argument is flawed because Price et al. does not teach that tungsten disilicide may be deposited on a nucleation layer without the presence of plasma. Rather, Price et al. indicates that once a nucleation layer of tungsten disilicide is formed by plasma discharge in the presence of a dichlorosilane silicon source gas, the reaction may continue without the continued presence of plasma. This is not equivalent to a disclosure that dichlorosilane may be used to deposit tungsten disilicide on a nucleated layer without the presence of a plasma discharge at a temperature below 500 °C. The disclosed Price et al. deposition of tungsten disilicide is a single-step process. Nowhere does Price et al. indicate that the deposition may be halted, and restarted, without again initiating the deposition with a plasma discharge. Thus, any combination with Kawanishi would require a deposition temperature over 680 °C or the initiation of the deposition using a plasma discharge.

Claims 1 and 8 are not obvious in light of the combination of Kawanishi and Price et al. because all of the limitations of claims 1 and 8 are not taught by the references and there is no motivation to combine the references to make obvious the claims. Thus, claims 1 and 8 are allowable. *See, In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

Claims 2, 4, 5, 9, and 12 through 17 are also allowable over the present rejection because they depend from independent claims 1 and 8. *See, In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596,

1600 (Fed. Cir. 1988)(dependent claims are nonobvious under section 103 if the independent claims from which they depend are nonobvious).

Independent claim 18 is also allowable over the present obviousness rejection because the combined references fail to establish a *prima facie* case of obviousness. Claim 18 includes the limitation “wherein said depositing said tungsten silicide nucleation layer and said depositing said film of tungsten silicide occur at a substantially equivalent temperature.” The combination of Kawanishi and Price et al. does not teach such a limitation because Kawanishi specifically discloses that the deposition must occur at substantially different temperatures and Price et al. does not disclose a two-step deposition process. Furthermore, as discussed *supra* with respect to claims 1 and 8, there is no motivation to combine a single-step plasma-initiated deposition process as disclosed by Price et al. with Kawanishi to teach the limitations of claim 18. Thus, claim 18 is allowable over the present rejection.

Claim 18 also recites the limitation of “switching said silane silicon source gas to said dichlorosilane silicon source gas occurring without interrupting said (CVD) process.” The combination of Kawanishi with Price et al. does not make this limitation obvious because Kawanishi specifically discloses that following a first deposition to form a nucleation layer the silicon substrate is removed from the reaction chamber and conveyed elsewhere before being conveyed to a reaction chamber for the second deposition step. Thus, any combination of Kawanishi and Price et al. results in an interrupted CVD process that fails to make obvious claim 18.

Claims 19 and 21 depend from allowable independent claim 18 and are therefore allowable dependent claims. *See, In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596, 1600 (Fed. Cir. 1988)(dependent claims are nonobvious under section 103 if the independent claims from which they depend are nonobvious).

Obviousness Rejection Based on Japanese Patent No. 2-39528 to Kawanishi in view of U.S. Patent No. 4,632,057 in further view of U.S. Patent No. 4,565,157 to Brors et al.

Claims 3, 6, 7, 10, 11, 20, 22, and 23 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kawanishi et al. (Japanese Patent No. 2-39528) in view of Price et al. (U.S. Patent No. 4,632,057) and further in view of Brors et al. (U.S. Patent No. 4,565,157). Applicant respectfully traverses this rejection, as hereinafter set forth.

Claims 3, 6, 7, 10, 11, 20, 22, and 23 depend from allowable independent claims 1, 8 or 18. Because the independent claims from which each of these claims depends is allowable, so too are the dependent claims. *See, In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596, 1600 (Fed. Cir. 1988)(dependent claims are nonobvious under section 103 if the independent claims from which they depend are nonobvious). Thus, the rejection of claims 3, 6, 7, 10, 11, 20, 22, and 23 should be withdrawn and the claims allowed.

Furthermore, the combination of Brors et al. with Kawanishi and Price et al. fails to establish a *prima facie* case of obviousness of claims 3, 6, 7, 10, 11, 20, 22, and 23. There is no motivation to combine the cold wall CVD reactor of Brors et al. with Kawanishi or Price et al. to achieve deposition of tungsten silicide as taught in the present invention. The lack of motivation to combine Brors et al. with Kawanishi and Price et al. precludes a *prima facie* case of obviousness. Therefore, claims 3, 6, 7, 10, 11, 20, 22, and 23 are nonobvious and allowable over the combination of Brors et al. with Kawanishi and Price et al.

Claims 20, 22, and 23 are also allowable over the rejection as dependent claims because there is no motivation or suggestion to combine Kawanishi, Price et al. and Brors et al. to produce an uninterrupted CVD process claimed by dependency from claim 18.

CONCLUSION

Claims 1 through 47 are believed to be in condition for allowance, and an early notice thereof is respectfully solicited. Should the Examiner determine that additional issues remain which might be resolved by a telephone conference, he is respectfully invited to contact Applicants' undersigned attorney.

Respectfully Submitted,



Devin R. Jensen
Registration Number 44,805
Attorney for Applicant
TRASKBRITT, P.C.
P.O. Box 2550
Salt Lake City, Utah 84110
Telephone: (801) 532-1922

DRJ/hlg:dh

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